

Sci Tech

DEPARTMENT OF COMMERCE

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UNIDIRECTIONAL RADIOBEACON FOR AIRCRAFT

During the development by the bureau of a directional beacon for guiding aircraft, it appeared that the usefulness of the beacon could be increased by making the radiated field unidirectional. This was accomplished by the combined use of a vertical antenna with the two crossed-coil antennas utilizing the directive and nondirective fields simultaneously, with the proper phase and amplitude relations between them to secure unidirectional transmission.

The system is explained in a paper Unidirectional Radiobeacon for Aircraft, by E. Z. Stowell in the Bureau of Standards Journal of Research for December, 1928, Research Paper No. 35. Reprint copies of this paper may be obtained for 10 cents from the Superintendent of Documents, Government Printing Office, Washington, D. C.

A LABORATORY INTERNAL MIXER FOR RUBBER

A small internal mixer for rubber has been installed recently. Various extrac-

tion and drying operations have been performed with the use of the mixer, in addition to the compounding of rubber for which it was designed.

The mixer consists essentially of shaped rotors moving in opposite directions at different speeds in a closed chamber. Temperature control is effected by a jacket for steam and water at the bottom of the chamber. The working capacity of the mixer is 500 to 2,500 grams of rubber. The machine is driven by a motor with variable speed control.

A variety of stocks have been successfully compounded with the mixer. Those containing large proportions of graphite have been mixed by the machine with greater facility, ease, and accuracy than on the usual laboratory roll mill. Sulphur, accelerators, and even ultra-accelerators are usually incorporated in batches in the mixer. Temperature control is not difficult, as in case of factory size internal mixers, on account of the relatively larger surface per unit volume of rubber.

No critical study has, as yet, been made of the performance of the laboratory internal mixer or of the properties of rubber compounded in it. However, such an investigation is contemplated.

The mixture has been used as an extraction apparatus by macerating rubber or other gums with successive portions of solvent in the closed mixing chamber. Since a large and continually renewed surface of the gum is presented to the action of the solvent, the extraction process is relatively rapid and efficient. Furthermore, it is possible to work with very soft and tacky gums that would be difficult to handle with usual laboratory extraction equipment. The machine has also been used to make special rubber cements having a wide range of consistencies.

The internal mixer has also been found convenient and effective for the drying of rubber. During this operation an inert gas, such as carbon dioxide, is usually circulated through the mixing chamber to carry out vapors and to avoid oxidation by air. The machine is designed to permit its operation with the chamber evacuated, but this feature has not yet been tested.

VARIABLES IN BURSTING-STRENGTH TESTER

The study of the bursting-strength tester, one of the most widely used paper-testing devices, has been extended by the bureau to include a number of alleged variables. In this tester a piece of paper is clamped underneath a circular aperture through which the paper is forced by hydraulic pressure acting against a rubber diaphragm in contact with the paper. The bursting pressure is recorded by a gauge.

Perhaps the most important finding of this study is that the higher results obtained with a rubber-faced clamp are due, not only to inadequate gripping of the paper in some cases, but to the decrease in aperture size as a result of the rubber ring expanding into the aperture under pressure. Hence it is probable that the proposed metal-faced

clamps will have to be made with an aperture equal to that of the compressed rubber-faced clamp, rather than the nominal aperture size, in order to give results agreeing with the older clamping device. Another important result of the study is that the clamping pressure of some of the testers was found to be inadequate for the range of pressures obtained in making bursting-strength tests. The pressures were evaluated by calibrating the compression springs, and critical pressures were determined for the various testers below which slipping of the paper during the test occurred.

Further findings of the investigation are that the size of the faceplate (above $1\frac{1}{4}$ inches), the nature of the diaphragms in use, the manner of installing the diaphragm, or the presence of air under the diaphragm do not appreciably affect the test results. A new motor-driven tester submitted for study was found satisfactory in most respects, but lacked sufficient plunger displacement to permit of renewing diaphragms and adjusting the amount of glycerin in the hydraulic chamber according to the official procedure. This defect is being remedied by the manufacturers. The tester also has greater operating speed than that prescribed by the standard testing method, but this does not appear to affect the test values.

This work is being done in cooperation with the manufacturers of the "Mullen" bursting tester, who are interested in improving its performance as far as possible.

COLLOIDAL CONTENT OF CHINA CLAYS

Included in the program of the china-clay investigation is a study of grain size distribution. While this has been carried out by the sedimentation process and application of Stokes's law down to a particle size diameter of 1.7 microns, the data indicated that from 35 to 60 per cent of the total clay had a grain size of less than 1.7 microns. Since this large quantity of finely divided material undoubtedly has a pronounced ef-

fect upon the properties of the clay, it seemed desirable to make a further classification as regards size.

After reviewing the literature and studying the methods of various investigators it was decided that centrifuging was the best way to effect the separation. Hand and motor driven centrifuges were tried, but the speed was insufficient, and a Sharples laboratory supercentrifuge was obtained. It was found that for a suspension of 1.6 specific gravity and a rate of flow of 20 liters per hour, the centrifuge would throw out of suspension all particles greater than 1 micron in diameter when rotating at 12,000 r. p. m.

The particle size was checked with a microscope using a 12.5X micrometer eyepiece and an oil-immersion objective. The second separation consisted in taking the suspension from the first and centrifuging it at a speed of 18,000 r. p. m. and a rate of flow of about 8 liters per hour. The material remaining in suspension after the second separation was removed either by centrifuging at 40,000 r. p. m. and a very slow rate of flow, or running through a set of Pasteur-Chamberland filters. The ultra-filters have a slight advantage over the centrifuge in that they remove every particle of suspended matter while the centrifuge leaves a trace in suspension.

The Bureau of Chemistry and Soils has done considerable work on the estimation of colloidal material by obtaining the adsorption of water or other liquids by the clay and by a sample of the total colloid. The adsorption in grams per gram of the total clay divided by the corresponding value for the total colloid gives the percentage of colloid. This method will be used to estimate the total colloid present in the clays. The figure obtained should check roughly the amount indicated in the earlier work as being under 1.7 microns. Then, to go further, it is desired to compare the quantities of material obtained from the second and final extractions of any one clay with like quantities from any other clay. If the same volume and the same concentration of suspension are used for

the various clays, then under similar conditions of centrifuging the actual amounts of material thrown out at any one speed should be relative and comparable. The separated material can be carefully removed, dried, and weighed.

Thus far data have been collected on a few clays only, but it is expected that considerable difference between one clay and another will be shown in the quantities of these fractions.

ABSORPTION OF CLAY BRICK

In connection with an investigation, sponsored by the American Face Brick Association, of the factors controlling the moisture transmission of brick masonry, a study has been made of the absorption properties of nine different types of clay brick. All bricks of one type were made at the same plant and differed from those of other types in the clay used and in certain details of manufacture. Among the nine different types investigated were included bricks made by the stiff mud and dry press processes. The samples of each type used in the absorption tests were selected to give as wide a range in the properties as could be obtained from several hundred marketable products. Those selected were free from large cracks or laminations. The absorption tests included measurements of the water absorption of brick by total immersion at room temperature, total immersion in boiling water for seven hours, and partial immersion at room temperature for several periods. The absorption by partial immersion was determined by noting the increase in weight of an initially dry brick when one surface was kept in contact with water and the other surfaces were surrounded by an atmosphere saturated with water vapor.

The results of the tests indicated that the relations between the amounts of water absorbed by total immersion at normal room temperature and by boiling were given closely by the empirical equation

$$Y = KX^3 \text{ or } Y = K\left(\frac{Y}{Y+Z}\right)^3, \text{ where}$$

Y =volume of water absorbed per unit of bulk volume of brick after total immersion at room temperature. (Taken at a period when the gain in the weight of the brick was less than 1 gram per 24 hours.)

$Y+Z$ =volume of water absorbed per unit of bulk volume of brick after seven hours' total immersion in boiling water.

K =a constant for one make of brick.

$X = \frac{Y}{Y+Z}$ = ratio of absorption by

cold immersion to absorption by boiling.

The absorption constant K was different for different types of brick, but was essentially constant for any one make of brick. Since the values of K were independent of the degree of burning and were constant for brick made from the same clay by the same manufacturing process, there seems to exist the possibility that clays may be classified in accordance with these values, though it has not been determined definitely to what extent (if any) they are affected by the manufacturing process.

With any one type of brick the values of the ratio X decreased with a decrease in the apparent porosity of the brick, but there was not a close relation between these two values with brick of different type. Since the quantity Z is that part of the total open-pore space which can be entered during the cold immersion test, it may be termed the residual porosity. By combining the

equation $Y = KX^2$ and $X = \frac{Y}{Y+Z}$ and solving for Z , it can be deducted mathematically that Z is a maximum when $X=2/3$. This relation was borne out by the results of the tests, the values of the residual porosity Z being greatest with any one type of brick when the value of the ratio X was about 0.67.

When a definite surface area of a brick is in contact with water at normal room temperature the rate of gain in weight of the brick because of water absorbed by capillarity has been in all cases such that $\frac{dW}{dT} = \text{a constant}$, B . W is the gain in weight of the

brick at any definite time interval T . In all cases wherein the rate of absorption was slow, thus making possible an error due to evaporation, the tests were conducted in an atmosphere saturated with moisture.

Performing the indicated operation $\frac{d}{dT} \left(\frac{W}{T^{3/4}} \right)$, there results the equation, $\frac{dW}{dT} - \frac{W}{3T} = BT^{1/4}$, which when integrated,

gives the equation, $C = \frac{W}{T^{3/4}} - BT$, where C is an integration constant. This latter equation has been applied to each of the nine types of brick studied. The quantity $\frac{W}{T^{3/4}} - BT$, has been found to be constant within the limits of experimental error for any one single individual brick among all of the nine types of brick studied.

Among brick of any one type, the magnitude of C is directly proportional to Y , the apparent maximum volume of water absorbed at room temperature per unit bulk volume of brick. This relation is expressed by equation (1),

$$C = K'Y^2 \text{ or } Y = \left(\frac{C}{K'} \right)^{1/2}.$$

But since (2) $Y = KX^2$, the value for Y in equation (1) may be substituted for Y in (2) and there results equation (3)

$$\left(\frac{C}{K'} \right)^{1/2} = KX^2.$$

Equation (3) contains every absorption property characteristic of any single brick selected from any of the nine manufacturers' marketable brick.

It is expected that noticeable deviations from these relationships will obtain in the case of any brick that is either distinctly underburned or overburned.

DIATOMACEOUS SILICA AS ADMIXTURE IN CONCRETE

A study of the representative diatomaceous silicas commercially produced in the United States for use as admixtures in concrete is now being made at the bureau; 11 representative samples having been obtained from 9 producers. The purpose of the study is

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the development of Federal specifications for this material.

The petrographic analysis, fineness through the No. 200 sieve, and weight per cubic foot have been determined. The material runs from a minimum of approximately 70 per cent diatomaceous silica mixed with quartz and clay to practically pure diatomaceous silica. All samples are finely divided from 86.2 to 99.5 per cent passing a No. 200 sieve.

As usual, the determination of the weight per cubic foot introduced difficulties, the weight of any one material varying according to the method whereby it is placed in the measure.

A one-third cubic foot aluminum measure, 8 inches in diameter, was made expressly for the measurement of the weight per cubic foot. The dried diatomaceous silica was always screened through a sieve into the measure. It was found that a one-eighth or one-fourth inch opening gave the same results. The one-sixteenth inch opening was too small, the material caking and blocking the sieve opening.

Hand sieving required such considerable time that motor-driven apparatus was built. A one one-hundredth horsepower motor drives through worm and wheel a vertical shaft, at the end of which another horizontal shaft forms a T. The horizontal shaft rotates over the screen surface and about one-sixteenth inch above it. If the distance above the screen is too great, the material will cake and if too close, it will touch the screen at some spot, cause movement of the screen and thus shake the material through, with a resultant change in unit weight. The weight per cubic foot will vary with the speed of the rod, and this speed will vary with the amount of material on the sieve. For this reason the diatomaceous silica is slowly added to the screen from a scoop, so that never more than one-half inch of the material is on the screen. The mean velocity of the rod is about 120 r. p. m.

The weights per cubic foot of the materials varied from 7.5 to 34.7 pounds.

Only one specimen, however, weighed more than 16.2 pounds per cubic foot, six of the specimens varying from 14.3 to 16.2 pounds per cubic foot.

PANEL TESTS OF LIME PLASTER

In March, 1922, a series of panels of lime plaster was erected, using several types of limes and intentionally including in the finish coat various impurities. The panels were allowed to age under ordinary laboratory conditions, and at the end of a year an inspection was made to determine the effect of the various impurities. The results of the first inspection were published by Emley and Berger in the *Journal of the American Ceramic Society*, Vol. 6, No. 9; September, 1923, under the title *Panel Tests of Lime Plaster*.

A recent inspection, made nearly seven years after the panels were erected, shows that while the majority of the panels are apparently in the same condition as in 1923, certain ones have developed defects not noticeable at that time.

In the construction of the panels four sets of duplicates were made containing, respectively, hydrated lime, lime plus coarse impurity, lime plus medium impurity, and lime plus fine impurity.

For convenience in reference, the 1923 report on the panels which have undergone change since then is given below, together with comments on their condition in December, 1928.

Hydrate No. 5 Plus Iron Carbonate.—

(1923) The hydrate itself shows a few pops and cracks. The additions of iron carbonate seem to have no effect.

(1928) Decided map cracking has developed on the panels containing lime without impurity. Numerous cracks and pops have occurred on the panels containing coarse and medium impurity; some have occurred on the panels containing fine impurity.

Hydrate No. 6 Plus Quicklime.—

(1923) The fine quicklime shows no noticeable effect; the medium shows a few additional pops, and the popping of the coarse particles is quite apparent.

(1928) Numerous pops have developed on the panels containing fine quicklime. (Hydrate No. 10 Plus Lime Burned During Hydration.—

(1923) The coarse particles caused a few pops; with the medium size the pops are almost negligible; and the fine material caused no popping.

(1928) Considerable cracking appears in the panels containing medium and fine burned lime.

(Hydrate No. 11 Plus Tannic Acid (Fine).—

(1923) The surface is badly checked and discolored.

(1928) Several large pops are noticeable.

The results of this later inspection indicate that while in the majority of cases defects which develop in lime plaster are noticeable at the end of a year, certain impurities may cause defects which are only apparent after several years' aging.

BUILDING CONSTRUCTION DURING NOVEMBER, 1928

During the month of November, 1928, the value of construction contracts awarded in 37 States, as reported by the F. W. Dodge Corporation, amounted to \$471,482,200, which was \$5,000,000 more than during the same month last year, but slightly less than in November, 1926. The cumulative total for the first 11 months of the year was 6 per cent in excess of the corresponding period in both 1927 and 1928, standing at \$6,203,429,800, the highest level ever attained for this period.

An increase of about 42 per cent occurred in the value of contracts in the Pittsburgh district during November this year as compared with last, and smaller percentage increases were recorded in the New York and northern New Jersey, Philadelphia, Chicago-St. Louis, and Minneapolis districts, while in the New England, southeastern, and Texas districts there were decreases. The value of contracts awarded for commercial buildings during the month was more than half again as great as in 1927. The only other important class to show an increase, as compared with a year ago, was that of public works and utilities. Declines in the value of awards of residential and industrial building contracts amounted to 7 and 27 per cent, respectively, as compared with November, 1927.

The various indexes of wholesale prices of building materials and of construction costs varied from approximately the same to a little higher than they were in November, 1927.

WILLING TO CERTIFY MANUFACTURERS

Nearly 2,000 separate manufacturing firms have expressed their desire to be placed on the bureau's list of "willing-to-certify" manufacturers, which now relate to 248 commodities. The average number of manufacturers on the separate 248 lists is 29, and the average number of lists on which the manufacturer's name appears is 3.79 as shown in the accompanying table which indicates also the progress made in the application of the certification plan during the past 13 months.

Date	Number of United States Government master specifications	Average number of willing-to-certify manufacturers per specification	Aggregate number of willing-to-certify manufacturers	Average number of specifications per manufacturer	Number of separate willing-to-certify manufacturers
November, 1927.....	75	21.4	1,609	2.35	684
March, 1928.....	145	22.3	3,229	3.15	1,022
December 26, 1928.....	248	29.8	7,393	3.79	1,952

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SIMPLIFIED INVOICE FORM

During the past month a large railroad system has reported to the division of simplified practice the following benefits from the use of the simplified invoice form: (1) Uniformity of size, permitting quick handling in the checking as well as filing, and maintenance of a neat record. (2) Uniformity of information, thus enabling various people who handle invoices to do it more quickly, as there is only one place for order number, terms, f. o. b., price, receipt of material, etc., which saves considerable time in checking and handling the invoices. (3) An employee once familiar with a single invoice is better able to handle invoices with more accuracy and dispatch, as information is shown at the same place on each invoice. This also applies to the shipper when making up the invoice, as to information that must be shown.

One purchasing agents' association is using stationery with the simplified invoice form printed on the reverse side. This is very conspicuous and effective. The Purchasing Agents Association of Los Angeles has forged to the front, in securing and forwarding reports covering the survey on the simplified invoice form. This association has forwarded 31 reports to date and expects to secure reports from at least 100 firms in their section.

The division of simplified practice invites all firms and associations to review their incoming invoices over a period of 10 to 15 days and then inform the bureau as to the number which conform in all respects to the simplified invoice form. Invoices which only partly conform to this standard should not be counted. These reports will be published in each issue of The Commercial Standards Monthly.

COMMERCIAL STANDARD FOR BRASS PIPE NIPPLES

A general conference of producers, consumer, and general interests held at the William Penn Hotel, Pittsburgh, Pa.,

on December 14, unanimously adopted a recommended commercial standard for brass pipe nipples, which requires that this commodity shall be made from new tested iron-pipe-size brass pipe in accordance with United States Government master specification, No. 342a. It also requires that the threads on such pipe nipples shall be cut and gauged in strict conformity to the American standard for taper pipe threads; that the end shall be properly chamfered to remove burrs and includes tables of stock sizes and number to be packed in cartons. The conference set July 1, 1929, as the effective date for new production and September 1, 1929, as the date for clearance of existing stock. The conference also unanimously voted to request the Bureau of Standards to prepare a list of willing-to-certify manufacturers on the basis of this commercial standard. A standing committee was appointed with the understanding that the commercial standard will be considered annually for revision in order that it may be kept continually in accord with current practice and the advance in the art.

NEW AND REVISED PUBLICATIONS OF THE BUREAU OF STANDARDS ISSUED DURING DECEMBER, 1928

Journal of Research¹

Bureau of Standards Journal of Research, Vol. 1, No. 6, December, 1928 (RP Nos. 32 to 36, inclusive). Price, 25 cents (foreign, 31 cents).

Research Papers¹

RP32. Physical properties of dental materials (gold alloys and accessory materials); R. L. Coleman. Price, 35 cents.

RP33. Use of the under-water spark with the Hilger sector photometer in ultra-violet spectrophotometry; H. J. McNicholas. Price, 5 cents.

RP34. Reaction of water on calcium aluminates; L. S. Wells. Price, 25 cents.

RP35. Unidirectional radiobeacon for aircraft; E. Z. Stowell. Price, 10 cents.

RP36. Studies of machines for extruding clay columns. Augers, spacers, and dies for brick machines; P. C. Grunwell. Price, 15 cents.

Scientific Papers¹

Volume 22, Scientific Papers of the Bureau of Standards; Nos. 547 to 572 (bound in cloth). Price, \$3. This is the last volume of the Scientific series, which is now superseded by the Bureau of Standards Journal of Research.

Handbooks¹

H4 (1928 edition). Discussion of the National Electrical Safety Code (to accompany the fourth edition of the code). Price \$1.

Simplified Practice Recommendation¹

R56-28 (supersedes R56). Carbon brushes and brush shunts. Price, 10 cents.

R81-28. Binder's board. Price, 5 cents.

R82-28. Hollow metal single-acting swing doors, frames, and trim. Price, 5 cents.

R90-28. Hack-saw blades. Price, 5 cents.

Technical News Bulletin¹

TNB141. Technical News Bulletin, January, 1929.

OUTSIDE PUBLICATIONS²

Electrical resistance and magnetic permeability of iron wire at radio-frequencies. G. R. Wait, F. G. Brick-

wedde, and E. L. Hall; Physical Review (Corning, N. Y.), Vol. 32, No. 6, p. 967; December, 1928.

The spectrum of ionized xenon. C. J. Humphreys and T. L. de Bruin; Science (New York, N. Y.), Vol. LXVIII, No. 1771, p. 573; December 7, 1928.

Effect of solorization upon the ultraviolet transmission of window materials. W. W. Coblenz and R. Stair; Transactions, Illuminating Engineering Society (New York, N. Y.), Vol. 23, p. 1121; November, 1928.

Report of the work of the Bureau of Standards during 1928 in the astronomical and allied fields. George K. Burgess; Popular Astronomy (Northfield, Minn.), Vol. XXXVII, No. 1, p. 19; January, 1929.

A brief historical survey of airplane instruments. W. G. Brombacher and K. H. Beij; Popular Aviation, Vol. 3, No. 6, p. 40; December, 1928.

A national hydraulic laboratory. L. J. Briggs; Paper read before the American Shore and Beach Preservation Association, Coney Island, N. Y.; June 26, 1928.

Importance of temperature and humidity control in rubber testing. F. E. Rupert; Industrial and Engineering Chemistry (Washington, D. C.), Vol. 20, No. 11, p. 1245; November, 1928.

Studies of iron and its alloys at the Bureau of Standards. H. W. Gillett; Engineering Foundation (New York, N. Y.), Bulletin No. 3; December, 1928.

Ceramic investigations at the Bureau of Standards. Ceramic division staff; Ceramic Age (Chicago, Ill.), Vol. 12, No. 5, p. 169; November, 1928.

Fineness and available lime content of chemical quicklimes. J. S. Rogers; Industrial and Engineering Chemistry (Washington, D. C.), Vol. 20, No. 12, p. 1355; December, 1928.

How the Bureau of Standards can serve State highway officials. H. C. Dickinson; American Highways (Grand Rapids, Mich.), Vol. IX, No. 1, p. 31; January, 1929.

¹ Send orders for publications under this heading, with remittance, only to the Superintendent of Documents, Government Printing Office, Washington, D. C. Subscription to Technical News Bulletin, 25 cents per year (United States, Canada, Cuba, Mexico, Newfoundland, and Republic of Panama); other countries, 40 cents. Subscription to Bureau of Standards Journal of Research, \$2.75 (other countries, \$3.50).

² "Outside publications" are not for distribution or sale by the Government. Requests should be sent direct to publishers.

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